

in particular in a mobile radio system having broadband channels in which signals are transmitted according to a TDMA/CDMA subscriber separation method.

DE 196 29 899 C describes a mobile radio system in which a bidirectional logic control channel LCCH is set up between a base station and a mobile station in  
5 a specific time slot. If there are no longer enough time slots available for additional traffic channels, the transmission of the LCCH is suppressed and, instead of this, a traffic connection is set up in the relevant time slot. This situation occurs during a soft handover, for example. If no additional capacity for traffic channels is required, in principle the LCCH is transmitted in its time slot. The bidirectional  
10 LCCH is transmitted in a point-to-point connection.

In radio communications systems, information (for example, voice, image information, Internet messages or other data) is transmitted with the aid of electromagnetic waves via a radio interface between the transmitting and receiving radio stations (base station or mobile station). In this case, the electromagnetic  
15 waves are radiated with carrier frequencies within the frequency band provided for the respective system. Frequencies in the frequency band of approximately 2000 MHz are envisioned for future mobile radio systems having CDMA or TDMA/CDMA transmission methods via the radio interface; for example, the UMTS (Universal Mobile Telecommunication System) or other 3<sup>rd</sup> generation  
20 systems.

For the transmission of organization information items, various methods are known which serve to supply mobile stations in a radio cell of a base station with the data which is required for the radio cell. Organization information items are details regarding the radio cell, the channel structure thereof and services and  
25 options which are available in the radio cell. The organization information items are thus used by the mobile station for the synchronization and selection of the radio cell.

From the GSM mobile radio system and, for future mobile radio systems, from DE 198 10 285, it is known to provide a time slot for the transmission of  
30 organization information items per frame in the downlink direction. To that end,

use is usually made of the first time slot of the frame and the information items are transmitted in radio blocks; i.e., in a burst-like manner. There are thus fixed spacings between the transmissions of the organization information items, which are planned in such a way that even in unfavorable traffic load situations and with  
5 the maximum permitted speed of the mobile stations, a proper evaluation of the organization information items and a handover of the mobile stations between different radio cells are supported.

Since the organization information items are usually transmitted with high and constant power, they represent a considerable source of interference within the  
10 radio communications system. The effect of the interference is intensified with increasing density of the radio communications system; for example, as a result of microcells and picocells. The transmission capacity of the radio communications system is adversely affected.

The present invention is, thus, directed to a method and a base station which  
15 reduce the interference within the radio communications system.

#### SUMMARY OF THE INVENTION

According to the present invention, therefore, in the radio communications system, although at least one of the time slots of a frame is provided for the transmission of organization information items, the transmission of organization  
20 information items is suppressed at least in one of the frames by the base station depending on a change in the quantity of information items to be transmitted.

As a result, the number of transmissions of the organization information items per unit time decreases, and thus so, too, does the interference.

A small quantity of information items to be transmitted denotes situations of  
25 low traffic load; that is to say, in the domestic sector with very small radio cells and only a small number of subscribers. Such situations are regularly accompanied by a low degree of mobility and/or alteration of the conditions for the radio interface between the mobile stations and the base station. In these cases, the suppression of the transmission of the organization information items as provided according to the  
30 present invention does not constitute a restriction for the mobile stations. The

advantages of interference reduction predominate. In this case the information can be transmitted in radio blocks, (i.e., according to a discontinuous-time TDMA subscriber separation method), or continuously (e.g., according to CDMA subscriber separation methods).

5           In alternative embodiments of the present invention, the quantity of information items to be transmitted is determined relative to mobile stations or connections supplied by the base station. The fewer mobile stations which stay or are currently active in the radio cell and transmit and receive information, the less critical it is to effect continual supply with organization information items. The  
10       quantity of information items to be transmitted changes when new subscribers are logged on or subscribers log out. A further case is the change in a service for existing connections; e.g., when switching to a higher-rate service.

          The spacing of the frames having organization information items is advantageously determined by a repetition rate having a value greater than one. The  
15       repetition rate can be set to two, three or higher values. Thus, at least one frame remains without organization information items. The repetition rate used is advantageously signaled to mobile stations by the base station, so that other information items, e.g. useful information items, also can be transmitted in the time slots liberated.

20           According to an alternative embodiment of the present invention, the organization information items are transmitted only upon request by a mobile station. Such a request is transmitted in the uplink direction when the mobile station wishes to use radio resources in order to effect transmission itself or to set up a traffic relationship with a base station for the interrogation of information. The  
25       transmission of organization information items can be dispensed with for the rest of the time.

          A particular application of the present invention is in radio communications systems in which a switching point between transmissions of the base station and from mobile stations is provided within a frame, so that the information items are  
30       transmitted according to a TDD transmission method (TDD Time Division

Duplex). Such a radio communications system is suitable for the operation of microcells; e.g., in the unlicensed domestic sector. Moreover, as a result of shifting the switching point, this system also can provide asymmetrical data services without wasting radio resources e.g., for supporting the Internet, without wasting  
5 radio resources. By suppressing the organization information items at least occasionally, useful information items can be transmitted from the base station in the frames having suppressed organization information items in all time slots of a frame. This increases the maximum data rate available; which, in the extreme case, can be utilized solely in one transmission direction.

10 Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Invention and the Figures.

#### BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a block diagram of a mobile radio system.

15 Figure 2 shows a schematic illustration of the frame structure of the TDD transmission method.

Figures 3 - 6 show schematic illustrations of a variable channel structure for organization information items.

Figure 7 shows a schematic illustration of the transmission of organization  
20 information items when required.

Figure 8 shows a flow diagram of the transmission of organization information items.

Figure 9 shows a simplified block diagram of a base station.

#### DETAILED DESCRIPTION OF THE INVENTION

25 The mobile radio system illustrated in Figure 1, as an example of a radio communications system, includes a multiplicity of mobile switching centers MSC which are internetworked and which establish access to a fixed network PSTN. Furthermore, these mobile switching centers MSC are each connected to at least one device RNM for allocation of radio resources. Each of these devices RNM, in  
30 turn, enables a connection to at least one base station BS. Such a base station BS

can set up a connection, via a radio interface, to further radio stations; e.g., mobile stations MS or other mobile and stationary terminals. At least one radio cell Z is formed by each base station BS. In addition, a plurality of radio cells Z are supplied per installed base station BS in the event of sectorization or with hierarchical cell structures. The device RNM for the allocation of radio resources and a plurality of base stations BS form a base station system.

Figure 1 illustrates connections V, designated by way of example as V1, V2, V<sub>k</sub>, for transmitting useful information items  $n_i$  and signaling information items  $s_i$  between mobile stations MS and a base station BS. The transmission of organization information items  $o_i$  is effected to a plurality of mobile stations MS in the form of a point-to-multipoint connection.

An operation and maintenance center OMC realizes monitoring and maintenance functions for the mobile radio system - or for parts of it. The functionality of this structure can be transferred to other radio communications systems in which the present invention can be used; in particular, for subscriber access networks with wire-free subscriber access. Base stations which are used as home base stations in the private sector, without being affected by the radio network planning, also can set up connections to mobile stations MS. These home base stations are connected to a fixed network.

A frame structure for radio transmission can be seen in Figure 2. Based on a TDMA component, a broadband frequency range, for example with a bandwidth  $B = 5$  MHz, is split into a plurality of time slots  $t_s$  having the same time duration, for example 16 time slots  $ts_0$  to  $ts_{15}$ . Some of the time slots  $ts_0$  to  $ts_9$  are used in the downlink direction DL, and some of the time slots  $ts_{10}$  to  $ts_{15}$  are used in the uplink direction UL. In between, there is a switching point SP. In this TDD transmission method, the frequency band for the uplink direction UL corresponds to the frequency band for the downlink direction DL. The same applies to further carrier frequencies.

Within a time slot which is provided for the transmission of information items  $o_i$ ,  $s_i$ ,  $n_i$ , information items for a plurality of connections are transmitted in

radio blocks. Alternative exemplary embodiments provide continuous-time transmission of the information items  $o_i$ ,  $s_i$ ,  $n_i$ . The aforementioned radio blocks for useful data transmission include sections with data  $d$ , in which training sequences  $tseq_1$  to  $tseq_n$ , which are known at the receiving end, are embedded. The data  $d$  is spread on a connection-specific basis with a fine structure, a subscriber code  $c$ , so that, for example,  $n$  connections can be separated at the receiving end by this CDMA component.

The spreading of individual symbols in the data  $d$  results in  $Q$  chips of duration  $T_{chip}$  being transmitted within the symbol duration  $T_{sym}$ . The  $Q$  chips in this case form the connection-specific subscriber code  $c$ . Furthermore, the time slot  $ts$  includes a guard time  $gp$  to compensate for different signal propagation times of the connections.

Within a broadband frequency range  $B$ , the successive time slots  $ts$  are organized according to a frame structure. Thus, 16 time slots  $ts$  are combined to form a frame  $fr$ .

The radio interface parameters preferably used are

Chip rate:	4096 Mcps
Frame duration:	10 ms
Number of time slots:	16
Duration of a time slot:	625 $\mu$ s
Spread factor:	16
Modulation type:	QPSK
Bandwidth:	5 MHz
Frequency repetition value:	1

These parameters allow the best possible harmonization with an FDD (Frequency Division Duplex) mode for the 3<sup>rd</sup> mobile radio generation. The switching point  $SP$  is advantageously chosen to be identical within a group of cells.

Figure 3 once again shows the known frame structure - organization information items  $o_i$  in each case being transmitted in the first time slot of a frame. In the remaining time slots, useful information items  $n_i$  are transmitted in the uplink

UL or downlink DL direction. The present invention departs from this rigid scheme in accordance with the frame structures as shown in Figures 4 to 6, the suppression of the transmission of organization information items  $oi$  being dependent on a change in the quantity of information items  $oi$ ,  $si$ ,  $ni$  to be transmitted.

5        According to Figure 4, the splitting of the frame  $fr$  in the uplink UL and downlink DL direction is preserved, but a time slot is used for transmitting the organization information items  $oi$  only in every second frame  $fr$ . A repetition rate  $rr$  is equal to two in this case. It is optionally also possible to choose a repetition rate  $rr$  of three or four. The interference caused by the transmission of the organization  
10    information items  $oi$ , which have to be transmitted with high and fixedly prescribed power, is reduced to a value which is proportional to the reciprocal of the repetition rate  $rr$ .

      Figure 5 shows that the repetition rate  $rr$  also can be less than one; i.e., organization information items  $oi$  also can be transmitted repeatedly per frame  $fr$ .  
15    This is done in the first and last time slots of part of the frame  $fr$  which is provided for the downlink direction DL. This low repetition rate  $rr$  is advantageous, particularly in radio cells having fast alterations of the transmission conditions for the mobile stations MS and many handovers to adjacent cells.

      Figure 6 is also an example of a repetition rate  $rr$  of two, the splitting in the  
20    uplink UL and downlink DL direction additionally having been cancelled at least for some frames  $fr$ . In order to obtain very high data rates in the downlink direction DL, for example, one complete frame  $fr$  is reserved for the transmission in the downlink direction DL; organization information items  $oi$  and useful information items  $ni$  are transmitted only in one transmission direction. The switching point SP  
25    within the frame  $fr$  is obviated. Consequently, it is also possible to support an extremely asymmetrical information transmission, which is required in Internet applications, for example.

      Figure 7 shows a case in which the transmission of the organization information items  $oi$  depends directly on the quantity of information items  $oi$ ,  $si$ ,  $ni$   
30    to be transmitted. The situation is shown whereby only one mobile station MS is

assigned to a base station BS in the domestic sector. A connection is not presently set up to this mobile station MS. No organization information items  $oi$  are transmitted in the first frame  $fr$  illustrated. Since there is no radio traffic at all between base station BS and mobile station MS, no interference occurs for adjacent  
5 radio cells.

However, if the subscriber to which the mobile station MS is assigned would like to establish a connection, then the mobile station MS uses a radio block containing signaling information items  $si$ , in a time slot of the second frame  $fr$ , to request the base station BS to transmit the organization information items  $oi$ . This  
10 is done in the subsequent frame  $fr$ . The mobile station MS can be synchronized with the organization information items  $oi$  and thereupon transmit useful information items  $ni$  in the uplink direction UL.

In the exemplary embodiment according to Figure 7, the organization information items  $oi$  are transmitted only when required. The physical transmission  
15 of a high-frequency signal in a time slot is performed only if beforehand a mobile station MS has transmitted such a request, such as an access block (access burst), or a timer has elapsed indicating that no organization information items  $oi$  have been transmitted for a specific period of time.

This method is suitable in radio communications systems having a  
20 multiplicity of uncoordinated base stations BS, in which the transmission power that is radiated in total is distinctly reduced and that the interference for base and mobile stations in adjacent cells decreases. The interference reduction is particularly important for radio communications systems having low frequency repetition values; e.g., a frequency repetition value of one. Furthermore, the  
25 interference reduction is particularly significant in the case of a TDD transmission method, in which the traffic in the uplink UL and downlink DL direction arises in the same frequency band B, if appropriate with a variable switching point SP from radio cell to radio cell.

The transmission - according to the present invention - of organization  
30 information items  $oi$  which contributes to interference reduction is illustrated

schematically in Figure 8. In a first step, information items  $oi$ ,  $si$ ,  $ni$  are transmitted by means of a TDMA/CDMA subscriber separation method. In a second step, the base station BS or another network device determines the quantity of information items  $oi$ ,  $si$ ,  $ni$  to be transmitted and the change therein; i.e., logging in or out of  
5 mobile stations MS or a change in the supported services. This is done for the uplink direction UL - Figure 7 - and for the uplink and downlink directions UL, DL - Figures 4 to 6.

In a third step, the quantity of information items  $oi$ ,  $si$ ,  $ni$  to be transmitted is compared with a threshold value. In this case, as variables representing the quantity,  
10 it is possible to use the number of mobile stations MS or connections to be supplied, the data rate to be transmitted or – (see Figure 7) as the smallest unit, a request for resource allocation. If the threshold value is not exceeded, then the information transmission is continued with the same repetition rate  $rr$  of the organization information items  $oi$ .

15 If the threshold value is exceeded, then an interrogation is made in a fourth step to determine whether the quantity of information items  $oi$ ,  $si$ ,  $ni$  to be transmitted is increased or decreased. If a larger quantity of information is to be transmitted, then the repetition rate  $rr$  is reduced in a fifth step. Otherwise, the repetition rate  $rr$  is increased in a sixth step. The information transmission is  
20 continued with the structure of the transmission of the organization information items  $oi$  which is defined by the repetition rate  $rr$ .

The information transmission is carried out in a base station BS according to Figure 9. The administration of the switching point SP and details for the offered services are influenced by the organization and maintenance center OMC  
25 and the stipulations of the device RNM for the allocation of radio resources are taken into consideration. The base station BS contains a transmitting/receiving part TX/RX for high-frequency processing of transmission and reception signals.

Furthermore, a transmitting device SE and a receiving device EE are connected to the transmitting/receiving part TX/RX. In the transmitting device SE,  
30 the signals are subjected to digital/analog conversion and converted from baseband

to the frequency range for radiation, and the transmission signals are modulated. A signal conditioning device SA has previously compiled the information items oi, si, ni to be transmitted in radio blocks and assigned them to the corresponding frequency band and time slot. A signal processing device DSP evaluates signals that  
5 are processed via the receiving device EE, in a manner corresponding to the transmitting device SE, and carries out channel estimation and data detection.

The interaction of the components, the setting of the switching point SP and the assignment of the organization information items oi to the time slots are controlled by a control device ST. Associated data relating to the transmission and  
10 switching point SP, the specific characteristics of the connections and the scheme for transmitting the organization information items oi are stored in a memory device MEM. The scheme is updated in accordance with the quantity of information items oi, si, ni to be transmitted.

Although the present invention has been described with reference to specific  
15 embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

#### ABSTRACT OF THE DISCLOSURE

A method and base station for the transmission of organization information  
20 items in a radio communications system wherein, in the radio communications system, although at least one of the time slots of a frame is provided for the transmission of organization information items, the transmission of organization information items is suppressed at least in one of the frames by the base station depending on a change in the quantity of information items to be transmitted. As a  
25 result, the number of transmissions of the organization information items per unit time decreases, and thus so, does the interference. A small quantity of information items to be transmitted denotes situations of low traffic load; that is to say, for example, in the domestic sector with very small radio cells and only a small number of subscribers. The present method and base station can be used in  
30 CDMA and TDMA transmission systems.